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ABOVE-GROUND BIOMASS OF AUSTRALIAN ACACIAS IN THE SOUTHERN CAPE, SOUTH AFRICA

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ABSTRACT

Dimension analysis was used to estimate above-ground biomass of thickets of exotic Australian acacias, chiefly *Acacia cyclops* Cunn. ex G. Don. and *A. saligna* (Labill.) H. Wendl., at 15 sites in the southern Cape, South Africa. The thickets contained an average density of 5 200 acacia trees/ha; the trees varying between 5 and 10 m in height. A mean above-ground biomass of 104 t/ha (dry mass) was obtained, which is about three times the biomass of indigenous Fynbos vegetation. Acacia biomass composition on a dry mass basis was as follows: 64,7 % wood, 22,8 % brown twigs and 12,9 % browse. Pods and seeds contributed 41,2 % to the browse mass during November, but only 13 % between February and July. The economic feasibility of utilising acacia biomass as a means of controlling these woody weeds is considered.

UITTREKSEL

BOGRONDSE BIOMASSA VAN AUSTRALIESE AKASIAS IN DIE SUID-KAAP, SUID-AFRIKA

Dimensionele ontleding is gebruik om die bogrondse biomassa van ruigtes uitheemse Australiese akasias, hoofsaaklik *Acacia cyclops* Cunn. ex G. Don. en *A. saligna* (Labill.) H. Wendl., by 15 persele in die Suid-Kaap, Suid-Afrika, te skat. Die ruigtes het 'n gemiddelde digtheid van 5 200 akasia bome/ha gehad; die bome tussen 5 en 10 m hoog. 'n Gemiddelde bogrondse biomassa van 104 t/ha (droë massa) was verkry, wat ongeveer driemaal die biomassa van inheemse Fynbos plantegroei is. Akasia biomassa samestelling op 'n droë massa basis is as volg: 64,7 % hout, 22,8 % bruin takkies en 12,9 % takvoer. Peule en saad dra 41,2 % by tot die takvoermassa gedurende November by, maar slegs 13 % tussen Februarie en Julie. Die ekonomiese uitvoerbaarheid om akasia biomassa te gebruik as 'n metode om die houtagtige onkruid te beheer, word oorweeg.

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INTRODUCTION

Australian acacias, chiefly *Acacia cyclops* Cunn. ex G. Don. and *A. saligna* (Labill.) H. Wendl., are feral in the southern Cape Province, South Africa, where they have spread in thickets over some 3 000 km^2 (Taylor, 1975), reducing the farming and recreational value of land and ousting the indigenous vegetation (Hall, 1979). Mechanical or chemical clearing of the thickets for the establishment of pasture or crops is currently uneconomic in areas where the soil is inherently poor in plant nutrients. Consequently, much of the land occupied by the acacias remains unused, and they continue to spread and replace the indigenous vegetation. Direct use of the acacias for goat farming has failed, because the sale value of the animals does not meet the cost of food supplements and fencing (C. Uys and H. W. Sharp, pers. comm.). Thus, it is unlikely that significant reductions in the present extent and spread of the exotic acacias will occur in the foreseeable future, unless a commercial market for acacia products can be developed to help offset the cost of clearing operations.

There are indications that products of the Australian acacias have potential for commercial use. The photosynthetic tissue, pods, bark, twigs and stem-wood all have some putative value as animal fodder supplements, fuels (including alcohols, methane and charcoal), chemicals (including tannins and acetone) or fibres (Anon., 1978; Goodricke, 1978). However, before the economic feasibility of exploiting the usable products can be gauged, it is necessary to have information on the above-ground biomass of acacia thickets per unit area, and its distribution in the various components of the plant. Here we present regression equations relating mass of acacia products to stem diameter, and we consider the biomass yield, and its economic implications, of typical acacia thickets in the southern and western Cape.

STUDY AREAS AND METHODS

Destructive sampling to determine the relationship between basal diameter and the mass of the tree components was carried out at four localities between February and November, 1978. We sampled seven *A. saligna* and nine *A. cyclops* trees at the School for Boys near Faure (referred to as the Faure site), on the Cape Flats 20 km south east of Cape Town; five *A saligna* trees near Cape Point in the Cape of Good Hope Nature Reserve 40 km south of Cape Town; 30 *A. longifolia* (Andr.) Willd. saplings in the grounds of the University of Cape Town on the lower slopes of Table Mountain; and, 372 *A. longifolia* and *A. saligna* seedlings in a burned thicket near Constantia Nek 15 km south west of the University.

Stand characteristics were recorded in 15 sample plots at eight localities in the southern Cape, which were infested with pure or mixed stands of *A. cyclops, A. saligna, A. longifolia* and *A. melanoxylon* R. Br. (Appendix 1A). Within each study plot (variable area) each individual acacia was assigned to a stem diameter class (measured 100 mm above the ground), and the number of trees in each class was recorded. Percentage projected canopy cover, mean tree height, the approximate age of the stand (as reported by persons familiar with the area), percentage projected canopy cover of other genera, and soil texture, were also recorded.

Biomass was estimated by means of dimension analysis. This method, in which allometric relationships for trees of various sizes are applied to the size distribution in the stand, is considered to be best for estimating standing crop of woody stands older than 2–5 years (Madgwick, 1970; Whittaker & Marks, 1975). It has been applied successfully to temperate forest (Satoo, 1970; Whittaker & Woodwell, 1968), eucalypt forest (Attiwill, 1979), African savanna-woodland (Huntley, 1977) and *Acacia mearnsii* De Wild. plantations (Schönau, 1978).

Acacia cyclops and *A. saligna* trees with stem diameters ranging from 20–160 mm were measured for total height and canopy height and diameter, and then divided, after felling, into the following components: wood exceeding or equal to 20 mm diameter, green matter (including foliage, young shoots and immature pods), and mature pods. All components were weighed in the field, using 20 and 5 kg Pesola spring balances.

A dry mass : wet mass ratio was calculated from subsamples of each component, which were taken in polythene bags to the laboratory, weighed, dried to constant weight at 90 °C, and reweighed on a Mettler top pan balance. Estimates of numbers of pods per unit mass, and of bark mass : wood mass ratio, were also obtained from subsamples. The total biomass (or mass of a single component) per unit area of an acacia thicket was calculated, using Satoo's (1970) equation

$$W = (w'n)$$

where W is the total biomass (or mass of a particular component) per unit area; w' is the total (or component) mass of an average member of the size class; and, n is the number of trees per unit area in the approximate size size class. w' was obtained from the regression relationship between stem diameter of a tree and the mass of its components.

RESULTS

Biomass and stem diameter of trees

Acacia cyclops and *A. saligna* biomass was strongly correlated with stem diameter ($r \geqslant 0{,}93$ Figures 1 & 2, Appendix 2). This applied to both the dry and wet mass of the whole tree and of its component parts (wood, twigs and browse). The relationship between the common logarithms of diameter and mass was linear, and the standard errors for predicted mass (y) values were small for both species. The value of double logarithm regression for predicting biomass from a stem dimension, which was pointed out by Madgwick (1970), Satoo (1970) and Whittaker & Marks (1975), is confirmed yet again by our results.

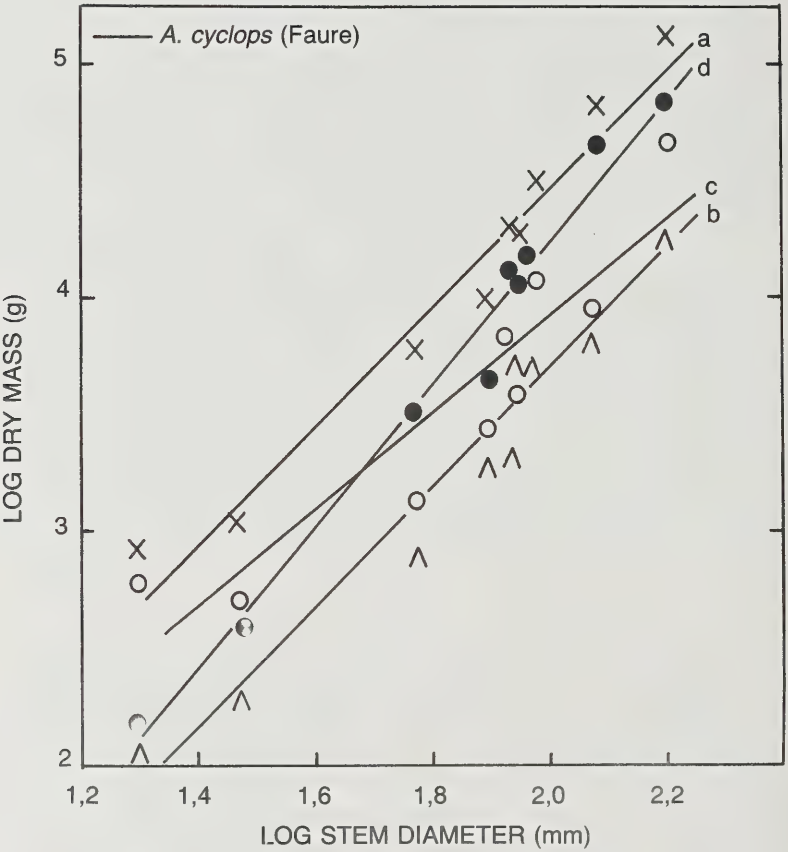

FIG. 1.
The relationship between log above-ground biomass (dry mass) and log stem diameter of *A. cyclops* trees at Faure. X = total above-ground mass of tree; ● = wood and bark; ○ = twigs; and ∧ = foliage (browse). For regression equations see Appendix 2.

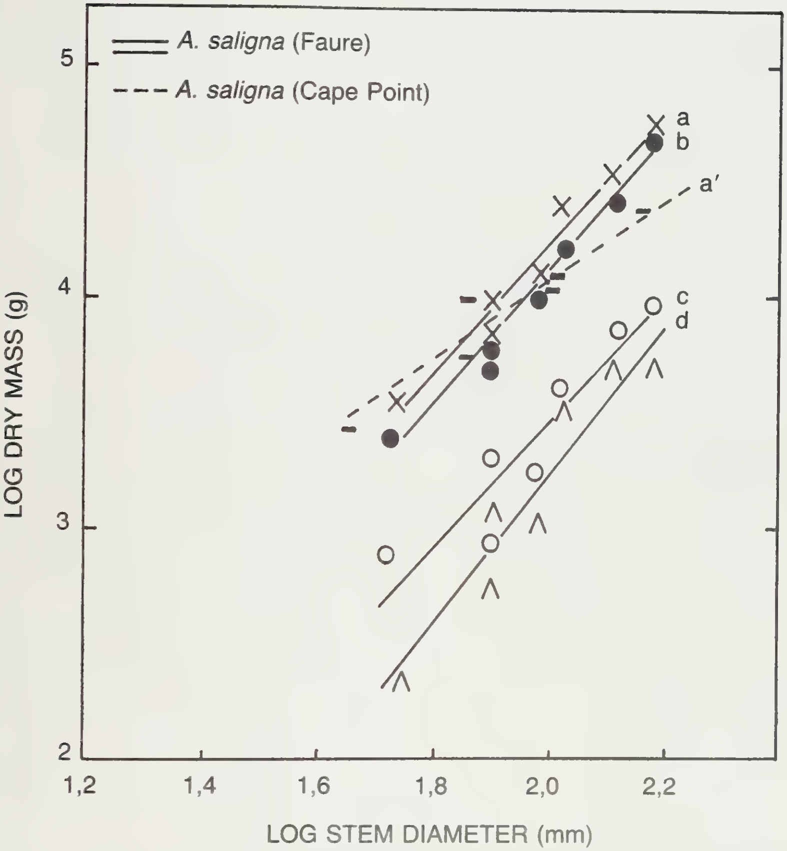

FIG. 2.
The relationship between log above-ground biomass (dry mass) and log stem diameter of *A. saligna* trees at Faure (continuous lines) and Cape Point (dashed line). X and — = total above-ground mass of tree; ● = wood and bark; ○ = twigs; and /\ = foliage (browse). For regression equations see Appendix 2.

The slope of the regression of log. total dry mass on log. stem diameter of *A. saligna* at Cape Point differed from that based on the Faure sample ($t_{calc.}$ = 2,43; $t_{2,9}$ = 2,26; P = 0,05; Figure 2). This difference can be attributed to the relatively exposed nature of the Cape Point site. Tree height there appeared to be limited by wind pruning, so that, for trees 4–5 m in height, stem diameter increments were not reflected in height increments (Fig. 3), and the plants remained shrubby rather than tree-like in appearance. There was no significant difference between the regressions for *A. cyclops* and *A. saligna* at the Faure site. ($t_{calc.}$ = 0,07; $t_{(2),12}$ = 2,18; P = 0,05).

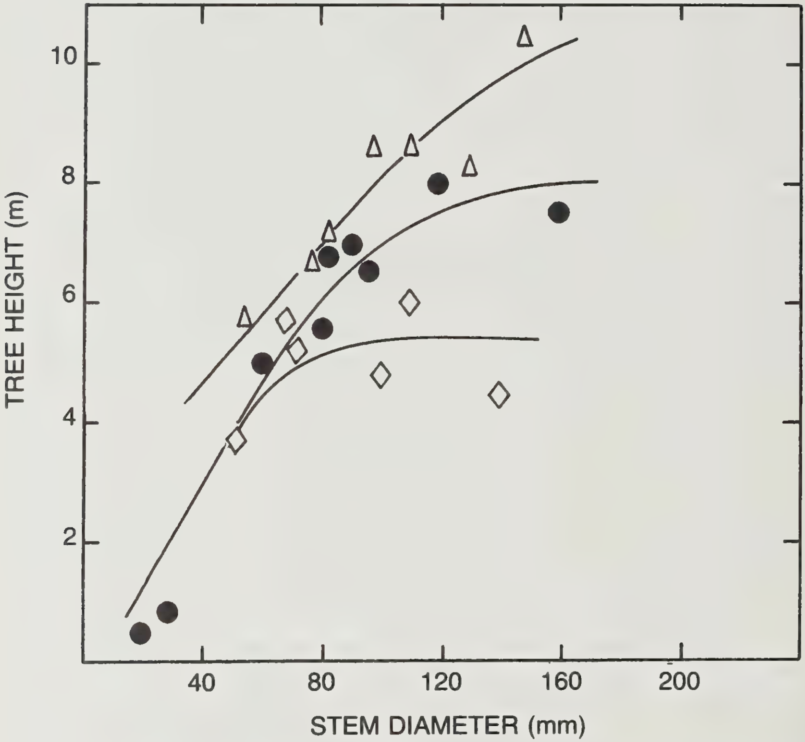

FIG. 3.
The relationship between tree height and stem diameter of *A. saligna* at Faure (△); *A. saligna* at Cape Point (◇); and, *A. cyclops* at Faure (●). Curves fitted by eye.

Biomass of stands and size–class distribution of trees

The product of the mass of a tree of average diameter and tree density per unit area was not used to estimate the biomass of a stand of trees, because the distribution of both tree abundance and mass in size classes was skewed strongly (Fig. 4). Moreover, acacia thickets are often associations of two or more species differing in their stem diameter : mass relationship and in the allocation of biomass to stem and canopy. Consequently, it was necessary to sample the frequency distribution of the stem diameter size classes in a thicket. The values used in estimating the biomass contribution of each size class and species within a stand are derived from the regression equations (Appendix 2). The total stand biomass (B) per unit area was calculated from the equation

$$B = \sum_{i}^{n} f_i b_i$$

where f_i is the frequency in the i-th diameter class, b_i is the biomass for the mid diameter tree in class i, and $i = 1,n$.

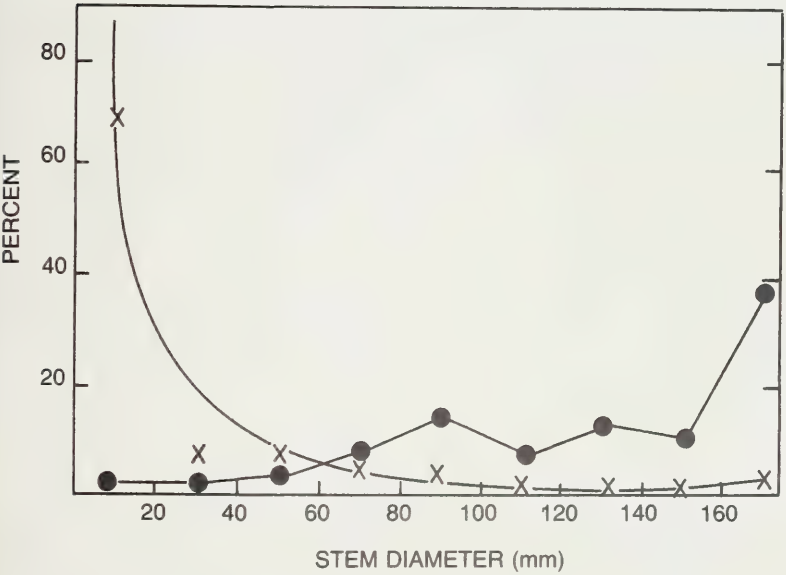

FIG. 4.

Percentage frequency of trees and percentage total biomass (dry mass) in mixed stands of *Acacia* spp. in the southern Cape, in relation to stem diameter classes. Line connecting crosses represents number of trees, and line connecting dots represents biomass. (Based on average of values in Appendix 1.)

In spite of the variation in habitat, age of trees, and species composition of the 13 mature acacia stands included in this study, the standard error of the average dry mass of a thicket (104 t/ha) was only 13 %. Stem diameters of trees in these stands ranged from <10 mm to >160 mm, and although only 2 % of all measured trees exceeded 160 mm in diameter, they should make the largest single contribution (38 %) to total stand biomass (Fig. 4), if the extrapolation of the regression line in Figure 1 is valid.

After clearing by fire, the acacias considered here regenerate in large numbers. Densities of up to 3 × 10^6 seedlings/ha were recorded nine months after a fire on the Cape Peninsula. The young plants grow rapidly. Populations thin quickly until, after five years, density is similar to that of mature stands (Fig. 5). However, numerous seedlings <10 mm in diameter and generally <100 mm in height may occur in mature stands, particularly during the rainy season. Field observations indicate that some seed germinates each year, but that seedlings have a low chance of surviving under a mature canopy. Hence, seedlings <10 mm in diameter were considered to be ephemeral, and are excluded from the values in Figure 5.

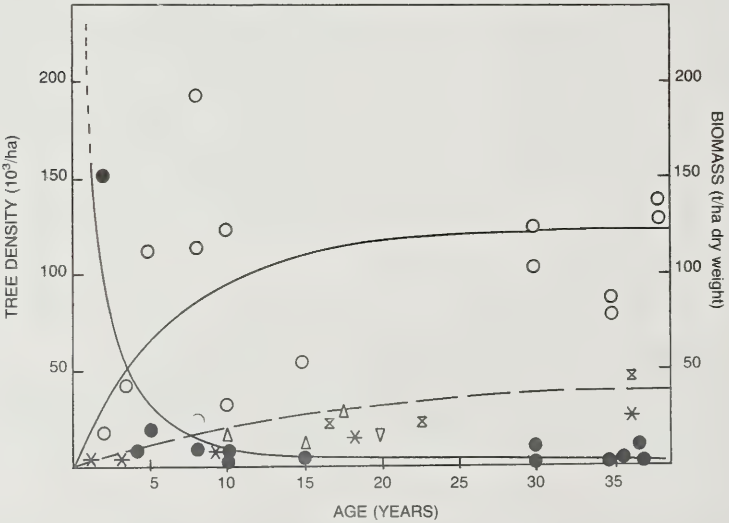

FIG. 5.

Density of trees and biomass (dry mass) in mixed stands of *Acacia* spp. in the southern Cape, and biomass (dry mass) of mediterranean-type vegetation, in relation to age. ● = density and ○ = biomass of acacia trees (based on averages of values in Appendix 1 and regression equations in Appendix 2). * = Australian Heath (Specht, 1969); ⧖ = French and Californian vegetation (Mooney, 1977); △ = Fynbos (Kruger, 1977) and ▽ = Fynbos (Kathan, 1979).

Biomass of the components of trees

All components of *A. cyclops* have a significantly ($P = 0{,}01$) higher dry mass per unit fresh mass than *A. saligna* (Table 1). The relatively low moisture content (34 %) of *A. cyclops* might be related to the species' natural occurrence in drier, windier habitats, and closer to marine shores, than *A. saligna*. The higher specific density of its wood explains why *A. cyclops* is more popular than *A. saligna* as a heating and cooking fuel.

TABLE 1

A comparison of mean dry : wet biomass ratios between *A. cyclops* (n = 9 trees) and *A. saligna* (n = 7 trees) in the south-western Cape. (Figures in parentheses are *C.V.*)

Component	*A. cyclops*	*A. saligna*	Significant difference
Wood (>20 mm diam.)	0,685 (1,6)	0,610 (3,4)	**
Brown twigs	0,727 (4,1)	0,470 (2,3)	**
Foliage & green twigs	0,429 (2,6)	0,361 (4,4)	**
Pods	0,380 (—)[a]	0,320 (—)[a]	—
....	0,906 (1,3)[b]		
Total for tree	0,660 (1,6)	0,534 (2,7)	**

[a] Mature green pods
[b] Non-deciduous ripe pods
** Significance level = 0,01

Used in conjunction with the dimension : mass regression equations (Appendix 2), stem diameter class frequencies (Appendix 1) and dry mass : wet mass ratios (Table 1), the values in Appendix 3 allow prediction of the amounts of wood, twigs, foliage and pods produced by stands of *A. cyclops* and *A. saligna*.

Clearly wood makes up the major portion of the total biomass (Fig. 6). The combined average biomass distribution of the two species is presented, since they were found to be equally common in the thickets sampled. However, where the two species grow under similar conditions, *A. cyclops* tends to be more highly branched, with the woody fraction (wood and bark) amounting to 57 % of the plant's total dry mass, as opposed to a comparable 72 % in *A. saligna*. The relatively large twig component of *A. cyclops* (Appendix 3) suggests that wood production per tree of a given diameter is lower than in *A. saligna*. This is not the case, however, because the relatively low wood volume is offset by the high wood density of *A. cyclops*.

Comparison between acacia and indigenous vegetation biomass

The above-ground, dry weight biomass of the exotic acacia thickets (104 t/ha) in the southern Cape is similar to that of forests (120 t/ha) in arid sub-tropical

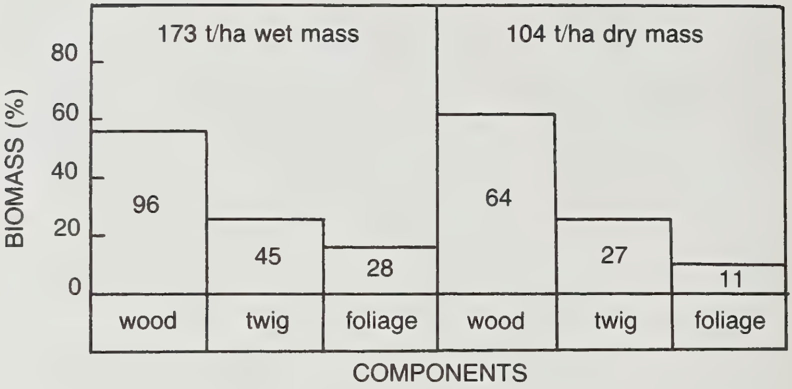

Fig. 6.
Distribution of biomass components in mixed stands of *Acacia* spp. in the southern Cape. (Based on values in Appendices 1 & 3.)

regions, whereas the biomass of the indigenous Cape Fynbos is typical of low shrub communities (20–30 t/ha) in these regions (Rodin *et al.*, 1975). Fynbos and similar mediterranean-type shrublands in France and Australia mature more slowly than the acacia thickets considered here and, when mature, the indigenous vegetation seldom attains a biomass greater than 40 t/ha (Fig. 5). Hence, after a fire, regenerating acacias rapidly outgrow Fynbos plants and maintain a position of dominance. The moisture content of *A. cyclops* (34 %) and *A. saligna* (47 %) is, however, similar to that of Fynbos (42–49 % Kathan, 1979; 32–44 % Kruger, *in litt.*) and Australian heath (30–42 % Specht, 1969).

Allocation of biomass in the acacias is similar to that of small trees in temperate regions (Whittaker & Woodwell, 1968; Satoo, 1970). In larger trees more of the biomass is allocated to wood than in shrubs, where more is allocated to twigs and foliage. The negative and exponential relationship between tree abundance and stem diameter found in the acacia thickets is similar to that existing in the indigenous forests of the southern Cape (Van Laar & Lewark, 1973).

Discussion

The above-ground biomass of the exotic acacia thickets in the southern Cape is comparable to that estimated for two ten-year-old *A. mearnsii* plantations in Natal (110 and 148 t/ha Schönau, 1978). However, whereas wood >20 mm in diameter accounts for 57 % and 72 % of the dry mass of *A. cyclops* and *A. saligna* respectively, it makes up 77–80 % of *A. mearnsii* plantation trees; foliage contributing only 5 % to total plantation biomass (Schönau, *op. cit.*). Self-established thickets of exotic acacias have a mean density of 5 267

($CV = 21\,\%$) trees/ha (Appendix 1B), whereas 1 280–1 440 trees/ha occur in *A. mearnsii* plantations. The wild thickets have a median basal diameter of 90 mm, and vary between 5 and 10 m in height, whereas ten-year-old *A. mearnsii* plantation trees have a breast height diameter of 125 mm and average 17,5 m in height (Schönau, *op. cit.*). These differences suggest that self-sown acacia thickets in the southern Cape produce less wood, and will be more difficult and expensive to harvest than plantation trees.

Although in Australia many acacia species are used as drought fodder, supplementary high-energy feeds and mineral licks are necessary (Everist, 1969). In Natal, leaves and twigs of *A. mearnsii* containing 5,7 % tannin were unpalatable to sheep. Moreover, since this fodder has low digestibility, the costs of its collection and processing are unwarranted in spite of its relatively high (18 %) protein content (Goodricke, 1978).

Harvesting and chipping of plantation biomass for use in the production of methane, alcohol, acetone or yeast, or simply for heating water to drive steam engines, is capital intensive. In order to produce methanol economically, for instance, it would be necessary to supply 1 million t/yr of plantation biomass, on a sustained yield basis, from an area within a 100 km radius of the processing plant (Anon., 1978). Clearly, felling, and the elimination of the non-uniform, self-sown acacia thickets in the southern Cape does not meet the prerequisites for the production of methane, alcohol or yeast on a commercial basis, and the necessity of hand gathering, would add to the production costs of acacia fodder.

Conclusion

At present there appears to be little possibility of financing the clearing of acacia thickets in the southern and western Cape, on a large scale, with revenue from the sale of the products. However, brush chippers are already being used by some South African municipalities for the demolition of thickets, and research into the best way of using the chips without further dispersing acacia seeds is needed. It also seems worthwhile to investigate the potential utility of acacia chips in small-scale methane digesters, charcoal burners and composters for small-holdings, and the effects of processing methods on the palatability and food value of acacia forage. The high productivity of the exotic acacias on soils generally considered to be very infertile, is probably attributable to their ability to accumulate nitrogen and phosphorus, and so enriching the soil. The possibility of growing vegetables in strips ploughed through acacia thickets should be investigated.

Acknowledgments

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APPENDIX 1A

Site and stand characteristics of exotic acacia thickets in the southern Cape

Locality	Geo-graphical co-ordinates	Distance from sea (km)	Soil texture	Stand age (years)	Stand height (m)	Canopy cover (%)	Cover by other spp.[a] (%)	Plot area (m^2)	*Acacia* spp.
Hout Bay	34 18 AB	6,0	clay	0,75	0,25	85	1	1	*saligna, longifolia*
Univ. Cape Town 1 . .	33 18 CD	6,0	clay	2	2,50	80	30	1	*longifolia, melanoxylon*
Univ. Cape Town 2 . .	33 18 CD	6,0	clay	15	6,00	40	5	25	*longifolia*
Cape Point	34 18 AD	0,5	sand	4	5,00	90	1	75	*saligna*
Rondevlei 1	34 18 AB	4,5	sand	35	7,00	70	1	100	*cyclops, saligna*
Rondevlei 2	34 18 AB	4,5	sand	35	7,00	55	4	25	*cyclops*
Faure 1	34 18 BA	4,5	sand	35	7,00	60	2	100	*cyclops, saligna*
Faure 2	34 18 BA	7,5	sand-loam	8	7,00	30	3	25	*saligna*
Penhill 1	33 18 DD	9,0	sand-loam	10	7,00	30	11	25	*saligna*
Penhill 2	33 18 DD	9,0	sand-loam	10	7,00	70	10	25	*saligna*
Marina da Gama	34 18 AB	1,0	sand	5	9,00	85	5	25	*cyclops, saligna*
Bredasdorp 1	34 20 CA	5,0	lime sand	?30	5,50	55	22	50	*cyclops*
Bredasdorp 2	34 20 CA	5,0	lime sand	?30	7,00	70	9	50	*cyclops*
Goukamma 1	34 22 BB	2,0	sand	35	8,00	55	1	25	*cyclops, saligna*
Goukamma 2	34 22 BB	2,0	sand	35	6,00	80	1	25	*cyclops, saligna*

[a] Percentage projected cover of plot area

APPENDIX 1B

Frequency of occurrence of exotic acacia plants according to stem diameter classes (mm) in study plots at localities in the southern Cape

Locality		Stem diameter classes									
		10	11–29	30–49	50–69	70–89	90–110	111–129	130–149	150–169	>169
Hout Bay	*longifolia*	372	—	—	—	—	—	—	—	—	—
	saligna										
Univ. Cape Town 1	*longifolia*	—	5	—	—	—	—	—	—	—	—
	melanoxylon	—	10	—	—	—	—	—	—	—	—
Univ. Cape Town 2	*longifolia*	—	2	3	2	—	—	1	1	—	1
Cape Point	*saligna*	—	7	15	21	13	7	1	—	—	—
Rondevlei 1	*cyclops*	—	4	3	7	7	4	2	—	—	7
	saligna	—	—	—	—	—	—	—	—	—	2
Rondevlei 2	*cyclops*	—	—	5	6	10	5	—	—	—	—
Faure 1	*cyclops*	40	40	15	1	—	—	—	—	—	—
	saligna	—	—	1	3	—	5	3	3	2	5
Faure 2	*saligna*	46	30	11	8	6	7	1	2	3	—
Penhill 1	*saligna*	—	5	2	—	—	—	—	—	—	1
Penhill 2	*saligna*	—	5	—	—	—	—	—	—	—	4
Marina da Gama	*cyclops*	82	30	—	—	—	—	—	—	—	—
	saligna	—	—	2	5	1	7	2	2	—	—
Bredasdorp 1	*cyclops*	—	2	2	6	4	1	1	2	2	1
Bredasdorp 2	*cyclops*	1	11	15	2	2	2	3	—	—	2
Goukamma 1	*cyclops*	150	—	1	1	1	2	—	—	1	—
	saligna	75	—	—	1	—	—	—	—	—	—
Goukamma 2	*cyclops*	3	—	—	—	—	—	—	3	—	—
	saligna	120	—	—	—	—	—	—	1	—	—

Appendix 2

Regression equations for *A. cyclops* and *A. saligna* trees in the south western Cape

a : total dry mass on stem diameter (log g/log mm)
b : wood dry mass on stem diameter (log g/log mm)
c : twig dry mass on stem diameter (log g/log mm)
d : foliage dry mass on stem diameter (log g/log mm)

A. cyclops (Faure)

a : $\log y = -0{,}61 + 2{,}54 \log x$ $SE(y) = 0{,}24$ $r = 0{,}979$
b : $\log y = -1{,}94 + 3{,}08 \log x$ $SE(y) = 0{,}30$ $r = 0{,}991$
c : $\log y = -0{,}16 + 2{,}03 \log x$ $SE(y) = 0{,}20$ $r = 0{,}925$
d : $\log y = -1{,}40 + 2{,}52 \log x$ $SE(y) = 0{,}24$ $r = 0{,}980$

A. saligna (Faure: continuous lines)

a : $\log y = -1{,}42 + 2{,}82 \log x$ $SE(y) = 0{,}16$ $r = 0{,}988$
b : $\log y = -1{,}61 + 2{,}85 \log x$ $SE(y) = 0{,}16$ $r = 0{,}995$
c : $\log y = -1{,}87 + 2{,}67 \log x$ $SE(y) = 0{,}16$ $r = 0{,}934$
d : $\log y = -3{,}12 + 3{,}17 \log x$ $SE(y) = 0{,}19$ $r = 0{,}951$

A. saligna (Cape Point: dashed line)

a′ : $\log y = 0{,}59 + 1{,}76 \log x$ $SE(y) = 0{,}14$ $r = 0{,}961$

Appendix 3

Mean wet and dry biomass distribution in above-ground parts of *A. cyclops* and *A. saligna* trees (50–160 mm diameter) in the south western Cape (standard error in parentheses).

WET MASS

	A. cyclops	*A. saligna*	*A. saligna*
Site	(Faure)	(Faure)	(Cape Point)
n	7	7	6
% wood & bark	54,3 (1,2)	63,6 (2,4)	42,8 (3,9)
% brown twigs	24,7 (2,2)	20,5 (1,7)	57,4 (4,0)
% browse (foliage & pods)	20,7 (3,0)	16,0 (1,2)	
pods as % of browse Feb.–July	14,5 (0,9)[2]	0,0 (0,0)[2]	0,0 (0,0)
pods as % of browse Nov.	62,6[1]	26,4[1]	—

DRY MASS

	A. cyclops	*A. saligna*	*A. saligna*
% wood & bark	57,1 (3,6)	72,3 (2,1)	—
% brown twigs	27,5 (3,0)	18,0 (1,5)	—
% browse	15,7 (2,2)	8,5 (1,5)	—
pods as % of browse Feb.–July	25,9 (2,0)[2]	0,0 (0,0)[2]	—
pods as % of browse Nov.	63,4[1]	18,9[1]	—

1 : n = 1 2 : n = 2

Analysis of variance for allocation of above-ground biomass

A. cyclops vs. A. saligna

Source of variance	*SS*	*DF*	*MS*	*F*	*Signif.*
% wood fresh mass					
treatment	301,8	1	301,8	5,51	P = 0,05
error	657,7	12	54,8		
total	959,5	13			
% wood dry mass					
treatment	808,7	1	808,7	13,30	P = 0,01
error	729,6	12	60,8		
total	1 538,3	13			
% twig fresh mass					
treatment	61,8	1	61,8	2,26	ns
error	328,1	12	27,3		
total	399,9	13			
% twig dry mass					
treatment	317,8	1	317,8	8,07	P = 0,05
error	472,3	12	39,4		
total	789,3	13			
% browse fresh mass					
treatment	87,0	1	87,0	2,10	ns
error	496,8	12	41,4		
total	583,8	13			
% browse dry mass					
treatment	117,7	1	117,7	5,70	P = 0,05
error	249,8	12	20,8		
total	367,5	13			
Cape Point vs. Faure					
% wood fresh mass					
treatment	1 396,2	1	1 396,2	21,99	P = 0,01
error	698,0	11	63,5		
total	2 094,2	12			
% browse & twig fresh mass					
treatment	1 406,8	1	1 406,8	21,64	P = 0,01
error	715,4	11	65,0		
total	2 122,2	12			